A Landscape Ecology Approach to Strengthen Protected Area Network in Gondia District of Maharashtra, India

Santosh Jha[1], Ashish Kumar Jha[2] And Rewati Acharya[2]
[1]dean- Faculty Of Commerce And Management Sciences, Datta Meghe Institute Of Medical Sciences, Wardha- 442004, India
[2]department Of Zoology, Hislop College, Nagpur- 440001, India
*Corresponding author:dr.santoshjha71@gmail.com

Abstract
Land degradation will be accelerated as a result of changes in land use brought about by industrialization, urbanisation and the expansion of agricultural land. Planners need to know the current distribution and area of such agricultural and urban lands, as well as information on their changing proportions. Land use managers should support the construction of a network of protected areas that contribute to natural resource conservation and sustainable usage. The current study considers a landscape-ecology approach to strengthening the protected area network in Maharashtra's Gondia district. According to the data, the district's land usage is classified into nine categories: (1) cultivated land (2) Forest area (3) land under non agriculture use (4) barren and uncultivated land (5)cultivable waste land (6) permanent pastures (7) land under miscellaneous tree crops and groves(8) current fallows (9) other current fallows.Despite the lack of data on the environmental impacts of these land-use shifts, the study finds that deforestation, urban growth, agriculture, and other human activities have all reduced the quality of land resources.The paper concludes with an integrated assessment of landscape ecology, as well as an examination of the basic protected areas and recommendations for improvement.
Keywords:land use, protected area network, Gondia district.

Introduction

The interaction of human activity and the natural environment is reflected in land use management sites around the world (Alonso-Pérez et al., 2003). Land scarcity, as a result of human population expansion combined with competitive land usage, results in the conversion of wild lands to agriculture and other uses (Kanianska, 2016). Land degradation will be accelerated as a result of changes in land use brought about by industrialization, the expansion of agricultural land, urbanisation, and the development of transportation networks, all of which have an impact on socio-culture, the environment, and quality of life (Wu, 2008; Ram and Kolarkar, 1993). Planners at the national, state, and local levels need to know the current distribution and area of such agricultural and urban lands, as well as information on their changing proportions, in order to develop better land use policies tailored to projected transportation and utility demand, identify future development pressure points and areas, and implement effective overall development plans(Clawson and Stewart, 1965).

Protected areas are a valuable tool for preserving ecosystems in the face of increasing development pressures (Carlson et al., 2019). There is a growing understanding that a protected area's conservation efficacy is best measured by how well it protects biodiversity

and ecological function (Ferraro and Pressey, 2015). Recognizing this issue, it is advised that land use managers support the construction of a network of protected areas that contribute to natural resource conservation and sustainable usage(Uberoi, 2003).

Gondia District, which was founded on May 1, 1999, when it was severed from Bhandara District, is one of the newest districts on Maharashtra's eastern border. Agriculture and forestry are the primary land use management sectors in the district. Rice is the most important cereal crop in the region, followed by wheat; the district also grows tur, gram, mung, urad, lentil, and other pulse crops. The district also grows groundnut, mustard, sesamum seed, soyabean, sun flower, and other oilseeds. Vegetable and fruit growing is practiced in almost every Tahsil. The forest includes a mix of planted and natural trees. High-quality teak trees can be found in these forests. Bija, Holda, Sisam, and Moha are some of the other trees present in these forest(Director of Census Operations, 2011).

This region is economically backward due to the lack of large-scale industry, and the majority of the people in Gondia district work in agriculture. So, according to the records available, the use of land in this district is divided into seven categories: (1) land under agricultural cultivation (2) land not available for agriculture (3) land under permanent pasture (4) land under cultivable waste land (5) land under forest (6) land under miscellaneous tree, crops, and groves (7) land under barren and uncultivable land (Bhuskute and Jha, 2014). The study offered in this paper is unusual in that it considers landscape-ecology approach to the improvement of the district protected area system in the future.

Methodology

Study Site

The current examination was conducted at several survey sites in the Gondia district, which are located at latitudes 20°40' and 21°38' north and longitudes 79°47' to 80°42' east. Gondia is bordered on the north by the Balaghat district of Madhya Pradesh, and on the east by the city of Dongarghad in Chhattisgarh. Maharashtra's SakoliTahasil and Bhandara district are to the south and west, respectively. On the Mumbai-Calcutta railway line, the district is located. The location of Gondia district is indicated in Figure 1. Primary and secondary data came from the tahsils of Tirora, Amgaon, Goregaon, Gondia, Salekasa, SadakArjuni, ArjuniMorgaon, and Deori.

Data collection, sampling, and analysis

From April 2019 to March 2020, data was collected on a monthly basis from a variety of key stakeholders. Secondary data was acquired and analysed from the office records (registers, reports and other records available at State, District, Block and Gram Panchayat levels). Secondary data was collected from journals, newspapers, and the internet, among other places. According to the objectives, primary data was collected through interviewing respondents at various levels. The stratified sampling strategy, which was based on the village data, was used to choose the samples. The samples of respondents were picked at random from the population of each group.

The respondents' responses were scored using a pre-determined criterion. Each respondent was assigned a score for each variable, which he was then provided. The scores were linked to the numerical values of the individual components.

Results and Discussion

Gondia District's Various Land Use Management Sites:

The geographical area of Gondia District is diverse in terms of land use management sites (Table 1). Because the Tahsil area and shape are determined by natural factors, there is no similarity between them. Gondia district covers a total area of 518240 hectares. Deori Tahsil has the largest area, accounting for 22.58 percent of the district, while Amgaon Tahsil has the smallest, accounting for only 6.16 percent (Table 2).

Table 1: Classification of land use patterns of Gondia district (Directorate of Finance and Statistics, 2021).

Land use pattern of the district (latest statistics)	**Area (ha)**
Geographical area	518240
Cultivable area	227882
Forest area	173178.6
Land under non agricultural use	22000
Barren and uncultivable land	27000
Cultivable waste land	44400
Permanent pastures	62400
Land under miscellaneous tree crops and groves	13200
Current fallows	5000
Other fallows	8000

Table 2. Classification of land use patterns in different Talukas of Gondia district (Directorate of Finance and Statistics, 2021).

	Tahsil	Total Geographical Area	Total Cultivated area (ha)	Total Forest area (ha)	Land under non-agricultural use	Barren and uncultivable land	Cultivable waste land	Permanent pastures	Land under miscellaneous tree crops and groves	Current fallows	Other fallows
1.	Gondia	64896	42199	9993	858	2308	9267.44	1960.42	6594.14	1672	2125
2.	Goregaon	68473	31392	17543	4619	1167	11125.92	2353.56	7916.52	574	1128
3.	Tiroda	75294	34135	5122	487	8697	18551	3924.25	13199.75	739	1289

4.	Arjuni / Morgaon	62867	26777	18314	7980	6159	5152.68	1089.99	3666.33	350	521
5.	Deori	117015	24292	58750	1568	2974	16020.16	3388.88	11398.96	577	1615
6.	Amgaon	31940	29720	3883	1431	262	3089.32	653.51	2198.17	391	475
7.	Salekasa	44251	17674	17351	1413	4976	2466.36	521.73	1754.91	486	1140
8.	Sadak / Arjuni	53504	21693	19882	3800	240	5819.84	1231.12	4141.04	212	416

Land under Cultivable area:

In general, land under agriculture is a significant category since it satisfies one of humanity's most basic requirements, namely food. In 2001, this district had 49 percent of its area under agriculture (Director of Census Operations, 2001). Similarly, 43.97 percent of the land in this area fell into this category in 2021. It demonstrates that between 2001 and 2021, the amount of land under cultivation has decreased by 5.03 percent. In this district, the land is used for housing and industrialization.

SadakArjuni Tahsil had 44 percent of its area under cultivation in 2001 (Director of Census Operations, 2001). There is no increase or decrease in the amount of land under cultivation in 2021. Tirora Tahsil had 48 percent of its area under cultivation in 2001(Director of Census Operations, 2001). In 2001, however, it was 45.33 percent. As a result, the amount of land under cultivation in Tirora Tahsil has decreased by 2.67 percent. In this category, Gondia Tahsil is significant. In 2001, 63 percent of the land was under cultivation (Director of Census Operations, 2001), and by 2021, it would have expanded by 2.02%, to 65.02 percent.

Area under cultivation in Salekasa Tahsil was 41 percent in 2001 (Director of Census Operations, 2001)and 39.94 percent in 2021, indicating an almost 1.06 percent reduction in land under cultivation. Only 20.75 percent of the land in Deori Tahsil was cultivated. Because of the forest in this Tahsil, the proportion is lower. Amgaon had 93.04 percent of its land under cultivation in 1991 (Directorate of Census, 1991), but only 95 percent in 2001 ((Director of Census Operations, 2001). The amount of area under cultivation has decreased by 1.96 percent.

Arjuni/ Morgaon Tahsil is recognised for being a distant and backward place. This Tahsil had 41 percent of its land under agriculture in 2001 (Director of Census Operations, 2001), but 42.59 percent in 2021. The amount of land under cultivation has increased by 1.59 percent.

As indicated by the existing data, there has certainly been a shift in land usage. It's possible that the land under cultivation has diminished as a result of land being utilised to construct

housing, industries, transportation, and other infrastructure. This is in line with what was reported by (Sharma, 2015; FAO, 2016; TERI, 2018).

Forest Covered Area:

In the Gondia district, the forest covered area plays a significant role in the classification of land use. The area covered by forest in Gondia district is shrinking, with only 29.1% of the district covered by forest. Forest comprised 40 percent of the land in 1991 (Directorate of Census, 1991), but just 32 percent of the land in 2001 (Director of Census Operations, 2001). This reveals that the amount of forest cover has decreased by 10.9 percent during the last three decades.

In 2021, Deori Tahsil has the most forest covered area with 50.20 percent, while Tirora Tahsil has the least forest covered area with only 6.80 percent. In 1991, the aggregate area of forest covered in Gondiadistrict was 40%, but by 2022, it had dropped to 29.1%. Anthropogenic pressure with humans encroaching into the forest and converting forest land into agricultural land and residential area, habitat fragmentation due to linear developments such as railway and roads, industrial development and mining all played a significant role deforestation. Similar observations have been made by others (Pandya *et al.*, no date; Thouless and Sakwa, 1995; Torres *et al.*, 1996; Naughton-Treves, Rose and Treves, 2000; Balmford *et al.*, 2001; Seiler, 2001; Singh and Sharma, 2001; Woodroffe, Thirgood and Rabinowitz, 2005; Balmford, Green and Phalan, 2012; Choubey, 2013; Ito *et al.*, 2013; FAO, 2016; TERI, 2018; Ranjan, 2019).

Land under non agricultural use:

Normally, land that is not suitable for cultivation is used for urbanisation, transportation, and industry(Dale and McLaughlin, 2000). In 2021, 4.24 percent of Gondia district's total geographical area was unsuitable for agriculture. In 2001, 9% of the land allocated for cultivation was unavailable(Director of Census Operations, 2001). In comparison to 2001 and 2021, 4.76 percent of land is used for non-agricultural purposes.

When we examine the area not available for agriculture in 2001 and 2021, we can see that the % of land unavailable for agriculture has changed in all Tahsils. SadakArjuni had 7.10 percent of its land unsuitable for cultivation in 2001(Director of Census Operations, 2001). In 2021, this percentage remained unchanged. SadakArjuni Tahsil has had very little development in the last two decades. However, due to the impending Adani Power plant, the installation of a new rice mill, and mushroom-like expansion in the housing sector, considerable percentage increases in this category were noted in Tirora Tahsil, Gondia, and Amgaon Tahsil in 2021. The amount of land not available for agriculture in Salekasa, Deori, and Arjuni/Morgaon has steadily increased in comparison to the previous year. These findings are comparable to those of (Sridhar and Wan, 2014; FAO, 2016; TERI, 2018).

Barren Land and Uncultivable Land:

Barren land is land that is unsuitable for farming. It is rocky rather than plain. According to records from 2001, the percentage of barren land in the Gondia district is 7% (Director of Census Operations, 2001). It dropped to 5.2 percent in 2021. It demonstrates how the arid area is exploited for agriculture, transportation, industrialization, and habitation. The

outcome can be seen in the reduction of barren land from 7% to 5.2 percent between 2001 and 2021.

The taluka wise data of barren land is different. Tiroda and Salekasa Tahsil had the highest percentage of barren land (12%) in 2001, while Amgaon had the lowest percentage of barren land (1%) (Director of Census Operations, 2001).

In 2021, Tiroda and Salekasa have the most barren land, at 11 percent, while Sadak/Arjuni has the least barren land, at 0.44 percent, followed by Amgaon with 0.82 percent. The decrease in barren land over the last two decades suggests that the land was put to good use, which is a good sign for the district. In all Tahsils, the percentage of barren terrain had decreased. This is in line with the findings of (FAO, 2016; Meshesha, Tripathi and Khare, 2016; TERI, 2018).

Cultivable waste land:

Cultivable waste land is land that has been left uncultivated for more than five agricultural years. This area can be fallowed and prepared for the growing of vegetables and small shrubs (Dale and McLaughlin, 2000). Uncultivable terrain becomes a cultivable wasteland as a result. In 2001, the percentage of land that was not under cultivation, excluding barren ground, was 11% (Director of Census Operations, 2001). It was 8.56 percent in 2021. It demonstrates that there has been a significant change from 2001 and 2021. There has been a 2.44 percent drop in cultivable waste land during the last 20 years.

Tiroda had the most cultivable waste land in 2021, with 24.63 percent, while Goregaon had the least, with 5.57 percent. The fact that cultivable waste has decreased over the last two decades indicates that the land has been well-used, which is a positive indicator for the district. The percentage of cultivable land had decreased in all Tahsils. This is in accordance with the observation of (FAO, 2016; TERI, 2018).

Permanent Pasture:

Permanent pastures are defined as land that has been utilised to grow grasses or other herbaceous fodder for at least 5 years, either naturally or artificially, and is not part of a crop rotation (Dale and McLaughlin, 2000. In 2001, permanent pasture accounted for 14% of the district's territory (Kumar, 2001).It was at 12 percent in 2021. The amount of cultivable waste land has dropped by 2% in the last 20 years..

In 2021, TiroraTahsil will have the most Permanent Pasture Covered Area (5.21 percent), while SalekasaTahsil will have the least Permanent Pasture Covered Area (1.17 percent).As the world's population continues to rise at an uncontrollable rate, increasing demand for food, land for houses, and other essentials, acreage under permanent pasture is diminishing (Maletta, 2014).As a result, people begin to use the pastural area as a place to build their homes or as farmland (Benjaminsen, Maganga and Abdallah, 2009). On a comparable basis, we are seeing a drop in the amount of land used for permanent pasture.

Land under miscellaneous tree, crops and groves:

Miscellaneous tree, crops, and groves includes any cultivable land that is not included in net area planted but is put to some agricultural use (Giri, 1967). Land under regionally known trees, thatching grass, bamboo, shrubs, and other fuel groves that aren't designated as

orchards fall into this category. In 2001, the percentage of land in this category was 5%. (Kumar, 2001). In 2021, it was 2.54 percent.It shows that there was a change from 2001 and 2021. Over the previous 20 years, land in this category has decreased by 2.46 percent.

The tahsil wise land record is not the same in this category. In 2021, Tirora Tahsil had the largest amount of land under miscellaneous trees, crops, and groves (17%), while Salekasa Tahsil had the least (3.96%). When comparing figures from 2001 to 2021, it is clear that the amount of land covered by various trees, crops, and groves has decreased, owing to the fact that more and more land is being cultivated each year.

Current fallow land

Fallowing is a cultural practise in which the land is given time to rest.Natural processes aid in the restoration of the earth's fertility. Fallow land is currently only left uncultivated for one or two agricultural years (Dale and McLaughlin, 2000). In 2021, 0.96 percent of land was classified in this category.

In this category, the tahsil-by-tahsil land record differs. In 2021, Gondia Tahsil had the largest proportion of Current fallow (2.57 percent), while SadakArjuni had the lowest (0.39 percent).

Other fallow land

This includes any cultivated land that has been left uncultivated for a period of not less than one year nor more than five years (Dale and McLaughlin, 2000). This group accounted for 1.54% of all land in 2021. In 2021, Gondia Tahsil had the largest percentage of other fallow (3.2%), while SadakArjuni had the lowest (0.77 percent).

The Protected Area Network is essential for the preservation of living resources.

Changes in land usage, on the other hand, are not free. In the present study there is a scarcity of data on the environmental consequences of these land-use shifts and the extent to which policy may influence them.According to Lubowski *et al.,* (2006) changes in land use are likely the most ubiquitous social force driving environmental changes and deterioration. The quality of land resources has been lowered as a result of deforestation, urban development, agriculture, and other human activities. Following Czech *et al*., (2000) habitat degradation, fragmentation, and change linked to urban development are the leading causes of biodiversity reduction and species extinction.Land use planning, proponents believe, safeguards agriculture, forests, water quality, open space, and wildlife habitat while also increasing property value and human health. Uncontrolled development, on the other hand, will devastate the natural ecosystem as well as long–term economic progress.

Protected areas maintain those essential ecological processes that rely on natural ecosystems(Hansen and DeFries, 2007); they preserve species diversity and genetic variation within them (Coates*et al.*,2018), preventing irreversible damage to our natural heritage; they maintain ecosystem productive capacities and safeguard habitats critical for the sustainable use of species (Bennett and Chaplin-Kramer, 2016); they provide opportunities for scientific research (Orlović-Lovren, 2011); and they give recreational and tourism opportunities(Heagney *et al.*, 2019), making protected areas an important contributor to long-term development.

Conclusions

Considering the current status of land use patterns in Gondia, Maharashtra, India, the main system for improvement will need to include the following.: 1) construction of new protected areas in ecological units of high importance and priority that have yet to be included in the conservation system, as well as promotion of basic conservation measures, 2) expansion of those protected areas that do not adequately cover ecological units of international and national importance and high priority, as well as the management project for such areas, 3) further development of those areas where a management project is already in place, with a particular focus on the development of rural areas and 4) establishment of special management regulations for the protection of ecological units that are yet outside the system.

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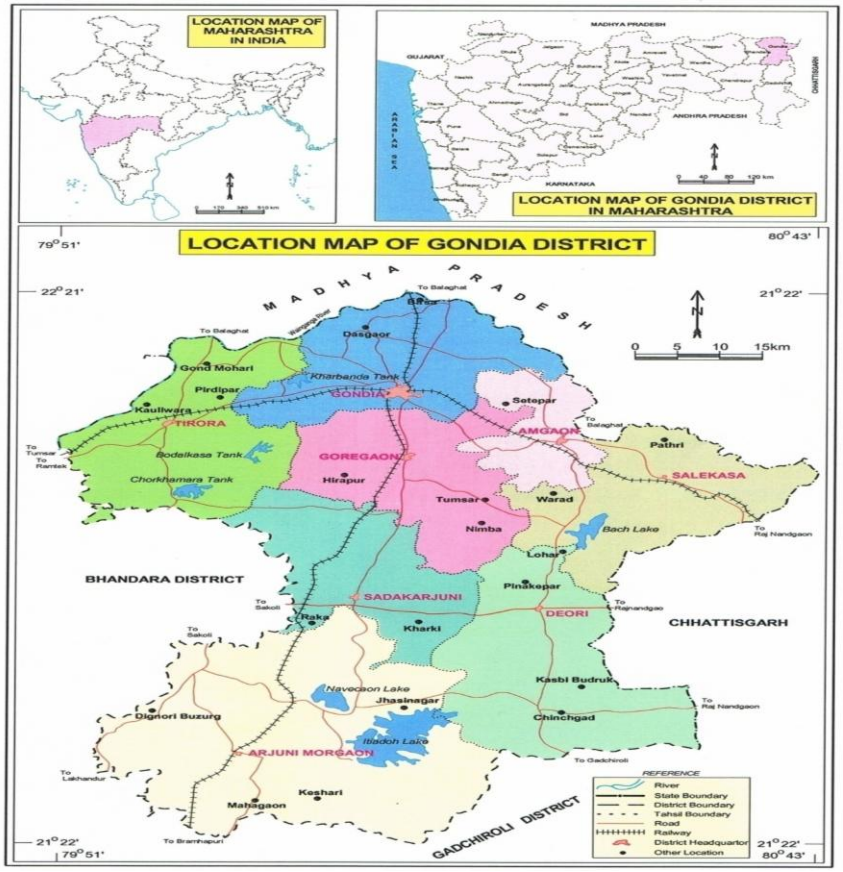

Fig. 1. Location map of Gondia District in Maharashtra state of India